Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Wave and Hydrodynamic Observations and Modeling in the Nearshore Beaufort Sea (AK-17-01)
Administered by	Alaska Regional Office
BOEM Contact(s)	Dr. Heather Crowley (heather.crowley@boem.gov)
Procurement Type(s)	Cooperative Agreement; Interagency Agreement
Conducting Organization(s)	University of Alaska Fairbanks; USGS Western Region
Total BOEM Cost	$2,123,903
Performance Period	FY 2017–2022
Final Report Due	September 2022
Date Revised	February 22, 2023
Problem	BOEM needs a better understanding of the physical processes related to wave conditions within Stefansson Sound, Beaufort Sea, the bottom conditions and depth-induced wave breaking conditions and their effects.
Intervention	Develop a high-resolution wave model and hydrodynamic model, including a field observation campaign to support model validation.
Comparison	Evaluate effects that climate change may have on sea ice, wind, and wave conditions, changes in sedimentation rates, and ice pile-up events.
Outcome	Documentation of current sediment transport conditions and forecasted changes due to higher waves, stronger currents, and diminished sea ice.
Context	Stefansson Sound in the Beaufort Sea Planning Area

BOEM Information Need(s): BOEM needs validated high-resolution wave and hydrodynamic model outputs to assess current and future wave conditions, their impacts on offshore oil and gas structures, and potential changes in sedimentation patterns and coastal erosion within Stefansson Sound and the nearshore areas of the Beaufort Sea. Specifically, BOEM needs information on the impacts that climate change may have on sea ice, wind, and wave conditions, changes in sedimentation rates, and ice pile-up events during the expected timeframe of the Liberty Development Project (~2020-2050). Coordinated field observations are needed for model validation because wave observations are quite limited in the central Beaufort Sea. Results from this study will inform monitoring activities associated with the planned Liberty Development Project and support NEPA analyses for future lease sales, EPs and DPPs.

Background: The shallow shelf area in Stefansson Sound is capable of modifying large wave events as they propagate shoreward. Depth refraction, shoaling, and dissipation processes due to shallow water bathymetric effects are difficult to represent in shallow water wave models. The area within Stefansson Sound and Foggy Island Bay are difficult to model due to the scarcity of wind and wave information, the complex shallow bathymetry and coastal topography, and the highly variable and mobile sea ice conditions. The 100-year return wave height and wave period are important considerations for the design of offshore fixed structures to support the topside oil and gas facilities. Likewise, rapidly changing climate conditions such as warmer temperatures, stronger winds, and reduced ice cover can adversely impact those shore-based facilities through larger, more persistent waves, thawing of permafrost, and increased coastal erosion.

Objectives:

- Obtain a better understanding of the physical processes related to wave simulations within Stefansson Sound, Beaufort Sea, the bottom conditions and depth-induced wave breaking conditions and their effects.
- Assess offshore wave and meteorological conditions within Stefansson Sound and compare those measurements to model results.
- Produce a 20-year wind and wave hindcast reanalysis dataset and document the minimum, mean, and maximum wind-wave events.
- Characterize wave conditions in Stefansson Sound over a 2, 5, 10, 20, and 30 year period based upon the model results and potential reduced sea ice conditions due to climate change.
- Develop a coupled wave-hydrodynamic-sediment transport model to document current sediment transport conditions; forecast changes due to higher waves, stronger currents and diminished sea ice.
- Through field observations, document wave, ice, and erosional conditions within Stefansson Sound and their impacts on offshore and coastal oil and gas facilities during the two years of field effort and compare to past assessments since the 1970s.

Methods: This study will produce high resolution wave output in the nearshore region to assess the impacts of waves on sea ice and offshore structures. A coordinated field effort will collect offshore observations using fixed moorings and buoys for validation of the proposed wave model for the Beaufort Sea. Additional field effort will be conducted to map ice pile-up events within Stefansson Sound. The study will develop a new wave model or enhance an existing wave model (e.g., the Simulating Waves Nearshore or SWAN model) to better simulate near shore wave conditions within the Beaufort Sea. Researchers will validate the model against field-deployed moorings that measure site-specific wave conditions over a two-year field season. The developed wave model will be coupled to a hydrodynamic model to evaluate potential nearshore impacts or changes in sedimentation rates or sites of deposition or erosion related to changes in current and wave energy resulting from construction of a gravel island for oil and gas production on the OCS. This work is intended to be coordinated with ongoing and future research funded by BSEE and BOEM to investigate the dynamics of sea ice freeze-up.

Specific Research Question(s):

1. What are the existing sea ice, wind, wave, and sediment transport conditions in Stefansson Sound?
2. How might these be affected by climate change?

Current Status: Awaiting final report.

Publications Completed:

Nederhoff K, Erikson L, Engelstad A, Bieniek P, Kasper J. 2022. The effect of changing sea ice on nearshore wave climate trends along Alaska's central Beaufort Sea coast. The Cryosphere Discussions.16:1609-1629. https://doi.org/10.5194/tc-2021-343

Zimmermann M, Erikson LH, Gibbs AE, Prescott MM, Escarzaga SM, Tweedie CE, Kasper JL, Duvoy PX. 2022. Nearshore bathymetric changes along the Alaska Beaufort Sea coast and possible physical drivers. Continental Shelf Research.104745. First published online 28 April 2022. https://doi.org/10.1016/j.csr.2022.104745

Affiliated WWW Sites:

http://www.boem.gov/akstudies/

https://www.aoos.org/foggy/